UNIMOLECULAR RECTIFIERS

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In 1997 we showed that hexadecylquinolinium tricyanoquinodimethanide is a unimolecular rectifier, both by scanning tunneling microscopy and also by using a Langmuir-Blodgett monolayer of this molecule, sandwiched between aluminum electrodes [1]. The current is due an allowed electronic transition between the highly polar zwitterionic ground state and an excited state with much less polarity [2]. Very recently we observed the same rectification between gold electrodes: this required a deposition of "cold gold" atoms atop the organic monolayer [3]. The current is as high as 100,000 electrons per molecule per second, five orders of magnitude higher than for the Al electrodes (mostly covered by oxide) [3]. The rectification ratio can be as high as 27, but decreases upon repeated scans [3]. A search for other molecules with similar rectification properties is underway.

[1] R. M. Metzger, B. Chen, U. Höpfner, M. V. Lakshmikantham, D. Vuillaume, T. Kawai, X. Wu, H. Tachibana, T. V. Hughes, H. Sakurai, J. W. Baldwin, C. Hosch, M. P. Cava, L. Brehmer, and G. J. Ashwell, “Unimolecular Electrical Rectification in Hexadecylquinolinium Tricyanoquinodimethanide”, J. Am. Chem. Soc. 119(43): 10455-10466 (1997).

[2] R. M. Metzger, "Electrical Rectification by a Molecule: The Advent of Unimolecular Electronic Devices", Acc. Chem. Res. 32(11): 950-957 (1999).

[3] T. Xu, I. R. Peterson, M. V. Lakshmikantham, and R. M. Metzger, "Rectification by a Monolayer of Hexadecylquinolinium Tricyanoquinodimethanide between Gold Electrodes", Angew. Chem. Intl. Ed. Engl., accepted and in press

Biographical sketch

Robert Melville Metzger was born in Yokohama, Japan of Hungarian parents in 1940, moved to Paris, France in 1946, to Merano, Italy in 1948, then to Los Angeles, CA in 1959. After degrees in chemistry from UCLA (1962 - research with W. F. Libby) and Caltech (1968 -with H. M. McConnell) and post-docs at Stanford (with P. G. Simpson and M. Boudart), Metzger taught Italian at Stanford (70-71) and chemistry at the University of Mississippi (71-86) and the University of Alabama (86-present), where he is Professor of Chemistry and Tricampus Director of the Materials Science Program. Metzger has published 166 papers, edited 3 books, got 1 patent, graduated 9 Ph.D's and 1 M.S,. and gave talks, or spent sabbatical or other leaves in 22 countries. In 1984 he became the first Coulter Professor of Chemistry at the University of Mississippi. In 1998 he received the Blackmon-Moody award for exceptional research at the University of Alabama.